value from observations of Mars is 8″·78, agreeing exactly with Michelson's light velocity and the mean constant of aberration. Some other astronomers favour a higher value of the solar parallax, such as 8″·86; but whichever value we adopt, and whether we prefer Cornu's or Michelson's determination of the light velocity, the conclusion is that there can be no such difference between the group velocity and the wave velocity as 2 or 3 per cent., unless indeed the usual theory of aberration requires serious modification. These considerations appear to me to increase the already serious difficulties, which cause hesitation in accepting the views of Young and Forbes. The advent of further evidence will doubtless be watched with great interest by scientific men.

One other point I may refer to in conclusion. Speculations as to harmonic relations between various spectral rays emitted by a glowing gas proceed upon the assumption that the frequency of vibration is inversely proportional to the wave-length, or, in other words, that the velocity of propagation V is independent of the wave-length, the question now at issue. If the views of Young and Forbes are correct, calculations of this kind must be overhauled. On the other hand, the establishment of well-defined simple ratios between wave-lengths would tend to show that V does not vary.

RAYLEIGH

August 15

ELECTRIC LIGHT IN COLLIERIES

AUGUST 9, 1881, witnessed the first practical application in the United Kingdom of the electric light to the illuminating of coal-mines. The Earnock Colliery, near Hamilton, Lanarkshire, belonging to Mr. J. Watson, has been fitted with Swan's incandescent lamps specially arranged with outer lanterns of stout glass, air-tight, and provided with steel guards. The workings in which the lamps were fixed are 118 fathoms, or 708 feet below the surface. Twenty-one brilliant little lights placed at the pit-bottom, in the roads, and at the actual face of the seam where active operations were in process, supply an illumination of a very different character from the dismal glimmer of an occasional Davy. The electricity was generated by a dynamo-electric machine at the surface worked by a special 12 horse-power engine, and conveyed by two cables, first along telegraph poles to the pit mouth, then down the shaft to the workings, in one section to a distance of half a mile. The overhead wires are naked copper wires of $\frac{3}{8}$ inch diameter, while those below ground are carefully insulated, and in the shaft are protected with an outer tube of galvanised iron. At suitable points of the circuit safety air-tight switches, the invention of Messrs. Graham of Glasgow, are inserted to afford control over individual lamps. The mine was visited two days after the installation of the light by members of the Mining Institute of Scotland, with whom was Mr. W. Galloway, whose remarkable experiments on the explosive effects of coal-dust will be remembered in connection with the more recent report of Prof. Abel. The party were photographed in the workings. An experiment was made with a lamp to test whether in the event of its being broken by accident a surrounding atmosphere of explosive gas would or would not be kindled by the strip of red-hot carbon before it had had time to cool. Into a box containing about three cubic feet of explosive gas a single lamp, removed from its outer protecting case of stout glass, was placed, and the current was turned on. The fragile bulb inclosing the incandescent carbon thread was then purposely broken, when the gas inclosed in the box immediately exploded. No such occurrence could possibly happen if the protecting case of stout glass is properly constructed. The risk of accident must be considered as immensely less than that of the ordinary Davy lamp, especially when it is remembered that with the brilliant light of the electric lamps they need no longer be carried in the hand or set down upon the floor near the actual spot where the coal is being got, but will be fixed overhead at a safe distance against the wall of the mine. The ease with which the light can be turned out during the firing of a blast is another point in their favour. The proprietor of the Earnock Colliery is greatly to be congratulated on the step he has taken. In 1880 the death-roll of the slain by explosions of fire-damp in Great Britain reached the figure of 499 persons. We venture to predict that the universal adoption of electric lighting in fiery mines would reduce this figure to one-tenth of its terrible proportions. How many years will it be, we wonder, before the adoption of electric lighting will be made compulsory by Act of Parliament? And how many colliery owners will discover, we would ask, when driven to this course by compulsion, that in the long run they effect an economy by discarding the clumsy and unsafe "safety"-lamp, which will so soon be numbered with the "flint mill" amongst the relics of the past?

SINGULAR STONE HATCHETS [1]

MONSIEUR PITRE DE LISLE has lately called attention to a singular class of stone celts or hatchets which have for the most part, if not indeed only, been found in Brittany and North-Western France.

These hatchets, instead of tapering away to a more or less conical point at what has been termed the butt-end, suddenly expand close at that part, so as to present a somewhat button-like termination. In one instance, at least, the hatchet ends in a spheroidal ball not unlike that which one occasionally sees on the horns of cows which are inclined to make too free use of their natural arms of offence. In the case of the hatchets, however, the button is at the opposite end to that which was in use for cutting. These blades vary in length from about three inches to as much as fifteen inches, and are all made of rocks belonging to the family of Diorites, principally of Aphanite.

M. de Lisle has given to these instruments the name of "*haches à tête*" or "*haches à bouton*," and has pointed out the similarity which in some respects they bear to hatchets of Carib origin and to the *merés* of New Zealand. In these instances the object in view in forming a projecting rib round the end of the blade was no doubt to afford the means of preventing it from slipping out of the handle or hand which held it. He thinks that the same object led the makers of these French blades to adopt the same form, and that the hatchets, after passing through a transverse hole in their hafts, were secured by cords wound around them, which abutted against the projecting rims at their small end. In his opinion there is a representation of this method of hafting to be seen among the sculptures on the dolmen of Mané-Lud.

It is a remarkable circumstance that the hatchets of this particular form appear to be restricted to so small a district of France, and not to occur elsewhere. M. de Lisle is in consequence inclined to assign the development of this type to a late period in the Neolithic age, and has offered some reasons for inferring that in Brittany the use of bronze hardly found a home, and that stone was the principal material employed for cutting tools when first that part of Gaul was brought in contact with Roman civilisation. It seems probable enough that in that as in other countries there were districts which lay far away from the principal highways of progress and civilisation, and where old-world usages prevailed long after material advances had been made in more fortunate but not very distant regions.

We may however be allowed to doubt whether the country of the Veneti, the most enterprising maritime tribe of Gaul, whose ships in the days of Julius Cæsar were already provided with chain-cables of iron, were

[1] "Les Haches à Tête de la Bretagne, etc." (Nantes, 1880.)

among those in the rear of civilisation. However this may be, M. Pitre de Lisle has done good service to archæology in publishing his monograph upon this peculiar form of stone implement or weapon.

INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES

UNDER the authority of the Comité International, representing several countries of Europe, the United States, and South America, there has been recently published, by Gauthier-Villars of Paris, an important volume of Memoirs by Dr. Broch (Directeur du Bureau), and Drs. Pernet, René-Benoît, and Marek (Adjoints du Bureau), on the following subjects relating to the determination of units of measure and weight.

As the intensity of weight varies with geographical position and height above level of the sea, the Comité give in their first memoir tables of the ratio of the acceleration of weight at the level of the sea, for different latitudes, to its acceleration at latitude 45° (Paris), to which latitude the Comité recommend that all weighings might be referred. The tables are based on the formula of Laplace, the coefficients of which are corrected by Broch in accordance with recent deductions as to the figure of the earth. In the second memoir, which relates to the tension of aqueous vapour, certain corrections of hitherto accepted results are also indicated, particularly the errors of calculation in Regnault's tables as shown by Moritz, and new tables are given for tensions at all absolute barometer heights for normal degrees from $-30°$ to $+101°$ C.

With reference to the fixed points of mercurial thermometers, the Comité adopted the proposition that the point 0° of the Centigrade thermometer should be fixed at the pressure of 760 mm., when determined in 45° latitude, and at the mean level of the sea. Also at the Congress of Meteorologists at Rome in 1879 there was adopted the proposition of Dr. Pernet, to fix the boiling point of water, 100° C., under the above pressure, so as to render strictly comparable the temperatures observed at different places. Degrees of temperature between these points are termed normal-degrees.

Tables are also given, by which may be calculated the weight of a litre of pure air in different latitudes and at different altitudes. In London (lat. = 51° 30′, alt. = 6·7 metres) the weight is 1·2938 grammes. The Comité have adopted the term litre for expressing the volume of a kilogram of pure water, instead of the term cubic-decimetre.

In a report by M. Herr on the Austrian unit of weight (Vienna, 1870), the volume of pure water at various temperatures is stated from the means of observations by Muncke, Stampfer, Kopp, and Pierre, the maximum density of water being taken at 3°·92796 C. By this formula there have been calculated, under the directions of the Comité, tables of the volume and specific weight of water from 0° to 30° C.

One of the principal works executed during 1878-9 was the comparisons of the standard kilograms at Vienna, Paris, and London. An elaborate report on these comparisons is given by M. Marek, who, by improved methods and instruments, has obtained great accuracy. The probable error of his weighings is about 0·002 mgr., or 1-500,000,000th part of the whole weight. The results also show that the material of which the standards are made, 90 per cent. of platinum and 10 per cent. of iridium, is of all known bodies the least affected by time or atmospheric changes.

In a paper on Fizeau's apparatus for determining the rates of expansions of bodies by heat, by means of an optical method founded on the phenomena of interference, Dr. Benoit gives the results of his own experiences with a similar apparatus. The results show the wonderful delicacy of Fizeau's dilatometer, as the expansions by heat of small specimens of platinum are shown in a manner incontestable to millionths of a millimetre (0 00000004 inch).

An interesting account of the establishment and objects of the Bureau is given in a preface to this volume by the Secretary to the Comité, Dr. Ad. Hirsch; and it is hoped that the efforts made by the Comité to bring about international agreement on the scientific points above referred to will commend themselves to all engaged in accurate work.

H. J. CHANEY

A MODEL PUBLIC LIBRARY

ENGLISHMEN are fond of descanting upon the evils of too much centralisation, which they see displayed in some foreign systems of government, urging the amount of red tape rendered almost necessary, its inflexibility, and lack of adaptation to the infinitely-varying circumstances of different communities. But, on the other hand, the extravagant cost of working every undertaking by a separate organisation, especially in a community not large enough to make such undertakings great matters, must come forcibly home to many of those who are naturally selected to work upon several.

There has lately come under our notice an admirable case of a public library avoiding this waste, securing all the energy of private zeal, and at the same time increasing the working power of it by becoming, as a public library should become, the centre of all secondary education and the parent stem of many and various branches. If any of the smaller towns of England feel that a free library would not in their case stand by itself on account of small income, we commend this to their notice as a specimen of the advantages of co-operation.

Watford has a population of about 10,000, and the penny rate on last year's gross rental of 34,589*l.* brought in 144*l.* 2*s.* Yet this small amount has developed round it an expenditure of 700*l.* a year, equal to five times the largest rate collected, besides a large outlay on buildings at the beginning, costing some 3000*l.* subscribed, in addition to the gift of the land. Ten distinct sections are worked in connection with it. The accounts of each are shown in a separate balance-sheet each year, and the agenda paper, with notice of committee-meetings, shows how methodically the work of each section is carried out and overhauled.

Section A, the Library proper, contains about 7000 volumes; a payment of three shillings a year, or fourpence a month, is required for taking books home to read; the yearly issues accordingly amount to about 12,000. The only *free* part of the library, the reading-room, shows a something similar use of books; it is patronised chiefly by young men in the winter time, under the arrangements of Section D. The small subscription enables the book committee to spend about 50*l.* a year in new books; magazines and periodicals being supplied by a separate club, connected, of course, with the institution. We should be glad to see the troublesome and irksome system of guarantors dropped. Towns which have freed themselves from the labour and annoyance they entail, though containing far larger proportions of the "great unknown" than can a place of the size of Watford, have found no evil result. The subscription also, though small, seems to render it less necessary here.

Section B is the School of Science and Art, the latter division showing clearly that the public library at Watford by no means attends to the wants of the industrial classes only, for non-Government pupils may pay six guineas a year for drawing only. For the benefit of the evening classes, at which non-Government pupils pay a guinea and a half for the year's instruction, and Government students (whose income, that is, or parents' income, does not exceed 200*l.* a year) half that, "the subjects are